ENTOMOLOGICAL NEWS

OCTOBER 1955

Vol. LXVI **No. 8**

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PUBLISHED MONTHLY, EXCEPT AUGUST AND SEPTEMBER, BY
THE AMERICAN ENTOMOLOGICAL SOCIETY
PRINCE AND LEMON STS., LANCASTER, PA.
AND
1900 RACE STREET, PHILADELPHIA 3, PA.

Subscription, per yearly volume of ten numbers: $5.00 domestic; $5.30 foreign; $5.15 Canada. Entered as second-class matter April 19, 1943, at the post office at Lancaster, Pa., under the Act of March 3, 1879. Acceptance for mailing at the special rate of postage provided for in paragraphs (d-2), Section 34.40, P. L. & R. of 1948, authorized April 19, 1943.

ENTOMOLOGICAL NEWS

ENTOMOLOGICAL NEWS is published monthly, excepting August and September, by The American Entomological Society at Prince and Lemon Sts., Lancaster, Pa., and the Academy of Natural Sciences, 1900 Race Street, Philadelphia 3, Pa., U. S. A.

PHILIP P. CALVERT, Editor Emeritus. R. G. SCHMIEDER, Editor. Editorial Staff: H. J. Grant, Jr., E. J. F. MARX, M. E. PHILLIPS, and J. A. G. REHN.

Subscription price, per yearly volume of 10 numbers: Domestic, $5.00; Foreign, $5.30; Canada, $5.15—U. S. Currency.

SUBSCRIPTIONS: Communications and remittances to be addressed to **Entomological News, 1900 Race Street, Philadelphia 3, Pa.**

ADVERTISEMENTS: Rate schedules available on request. Address, **Fred B. Jacobson, Advertising Manager, Entomological News, 1900 Race Street, Philadelphia 3, Pa.**

MANUSCRIPTS and all communications concerning same should be addressed to **R. G. Schmieder, Zoological Laboratory, University of Pennsylvania, Philadelphia 4, Pa.**

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ENTOMOLOGICAL NEWS

VOL. LXVI OCTOBER, 1955 No. 8

The Evolution of the Insect Orders

By HERBERT H. ROSS, Illinois Natural History Survey, Urbana, Illinois

Among students of the Insecta there seems to have been a reticence in making efforts to analyze comparative data in terms of phylogenetic concepts concerning the orders of insects. Perhaps this circumstance is due in some measure to an apparently inherent desire on the part of entomologists to avoid changes in group names and definitions, for progress in classification as in any other field of science cannot be made without some change. There has accumulated in the past several decades, however, a surprising amount of comparative data which contributes evidence concerning the relationships and evolution of the insect orders and suggests changes from previously published family trees of the insects. I have tried to summarize these data in the form of an emended family tree together with a brief outline of the characters contributing most to its formulation.

The insects arose a few hundred million years ago from the same ancestral form which gave rise to the centipedes and other members of the myriapod classes. In this wormlike ancestor, each body segment bore a pair of legs, several segments of the primeval body had united with the primeval head to form the head capsule which we consider as typically insectan, and the second pair of maxillae had fused to form an underlip or labium.

In one of the phyletic lines arising from this insect-myriapod ancestor the first three body segments and their legs became enlarged and the remaining segments became slightly reduced

as did also their appendages. This resulted in the division of the trunk into two distinct regions, the thorax specialized for locomotion and the abdomen specialized for housing many of the vital organs. This was the beginning of the insect line. In these early forms the young resembled the adults in general appearance and wings had not yet evolved.

Of these primitive wingless types five orders are still living, collectively termed the Apterygota. Three of these orders, the Diplura (diplurans), Protura (proturans), and Collembola (springtails), appear to represent an early branch in which the cheeks and labium fused into a cavity surrounding the remaining mouthparts, and the maxillae and mandibles evolved into elongate and highly specialized structures extremely similar in all three orders. The simple myriapodan tentorial arms attest the early genesis of this branch. The Collembola have retained a postantennal organ and the Protura grow by adding segments at molts, both primitive myriapod characteristics. From this it would appear that the primeval insect still retained these characters, and that they have been lost independently in two or three phyletic lines.

In certain respects one of the other apterygote orders is more primitive than the preceding orders. In this order, the Microcoryphia (machilids), vestiges of appendages persist on every abdominal segment and the mouthparts are extremely simple. The mandibles are almost crustacean in musculature, the mesal closing muscles of the opposing mandibles joining across the meson. In the Microcoryphia, however, the tentorium has developed dorsal arms and the beginnings of the posterior arms have evolved in the form of a bar across the back of the head. Paired tarsal claws were also evolved in these forms. The order Thysanura (lepismatids) exhibits several specializations over this condition. Several abdominal appendages are atrophied, but, and of more significance, the mesal muscles of each mandible are attached separately to the head, and the parts of the tentorium have enlarged and assumed the shape typical of higher insects, although the anterior and posterior parts only abut rather than fuse (Snodgrass 1952).

From an early point on the Thysanura stem, a phyletic line arose which developed wings, to form the ancestor of the winged insects. The earliest functional wings were undoubtedly uniformly fluted, creased fanwise, the veins forming along both the upper and lower edges of the crease, but the wings could not be folded in repose. The fluted-wing insects are termed the Paleoptera and the most primitive known representatives are primitive fossil members of the order Ephemeroptera (mayflies) (Edmunds and Traver 1954). Judging by the nymphs of this order, the anterior and posterior parts of the tentorium had fused in this early line to form the structure typical of all higher insects. Branches of the very early mayfly line evolved into the orders Paleodictyoptera, Megasecoptera, and others which became extinct at a relatively early date. In the primitive paleopterous line from which the higher insects ultimately arose, the next evolutionary step appears to have been the development of a second articulation on the mandible, exemplified by the order Odonata (dragonflies).

Because nymphs of living Ephemeroptera and Odonata are both aquatic, some authors believe that the first winged insects were similarly aquatic. The evidence of the tracheal system militates against this view. The Microcoryphia, Thysanura, the orthopteroid orders and most of the hemipteroid and neuropteroid orders have normal functional spiracles in the immature stages, hence it is certain that the species forming the evolutionary line connecting these orders likewise had these structures in the juveniles. In nymphs of both the Ephemeroptera and Odonata the spiracles have completely disappeared, and in these forms tracheal gills of various sorts have evolved. It seems moderately certain, therefore, that the first winged insects were wholly terrestrial, and that the surviving lines of the Paleoptera have evolved independently into forms quite different from their early ancestors.

The next great step in insect evolution was the development of a mechanism by which the wings could be folded and laid over the back in repose. This mechanism consists of a set of small sclerites situated in the membrane connecting the wing

with the body, and the development of large and relatively flat areas of the wing (by suppression of some of the fluting) separated by accentuated furrows. Insects of this type are termed the Neoptera. From the ancestral neopteran two lines arose, one developing into the orthopteroid orders and the other into the hemipteroid and neuropteroid groups. Of these two lines the orthopteroid has remained the more primitive. In most of its orders the mesotrochantin is a triangular sclerite, much as in the Paleoptera, and, except for the wings, the young are remarkably similar to the adults.

The majority of the orthopteroid insects appear to form a single phylogenetic unit in which the first abdominal sternite is reduced and the front wings are thickened and form a protective roof over the hind wings in repose. In winged members of the order Dermaptera the front wings are very short and the hind wings fold up into a compact mass. In the Orthoptera the hind legs are enlarged for leaping and, in the nymphs, the developing wing pads are juxtaposed so that the costal margin is mesal and the hind pad lies above the front pad. This curious condition is found in no other insects except the Odonata (Moore 1955). Characters of the proventriculus (Judd 1948) indicate that the orders Isoptera (termites) and Cursoria (cockroaches and mantids) are closely related. Members of the order Cursoria form an ootheca around their egg masses and the walking-stick insects form a similar ootheca around each egg. For this reason I am tentatively considering the walking sticks as the suborder Phasmodea of the Cursoria. In the Phasmodea the proventriculus is simpler than in other Cursoria but this could represent a reduced condition. The order Embioptera (web-spinners) may be a highly specialized offshoot from the orthopteroid line.

In the hemipteroid-neuropteroid line two evolutionary changes are apparent: (1) the mesotrochantin becomes a slender, straplike piece first moving freely in the leg membrane, then its base fusing with the mesopleurae so that the trochantin is represented by only a small, hornlike projection, and (2) more and more adult structures become suppressed

in the nymphs and appear only in the adult. The first change, but not the second, is found in the order Plecoptera (stoneflies) which also have a ringlike (primitive) first abdominal segment. It is therefore possible that the Plecoptera represent the earliest known branch from the base of the hemipteroid-neuropteroid line. In this line, beyond the point of a possible plecopterous offshoot, the ocelli became suppressed in the immature stages. After this occurred, the line divided to give rise to two vigorous branches, from one of which evolved the hemipteroid orders and from the other the neuropteroid orders (Holometabola).

The hemipteroid orders, in addition to lacking nymphal ocelli, form a closely-linked group of orders in which there occurs a gradual development of sucking mouthparts (Stannard 1955). The first definite step in this direction is found in the order Corrodentia (psocids), in which the lacinia of the maxilla forms a chisel-like piece. The next evolutionary step is found in the order Thysanoptera (thrips), in which the mouthparts are of a rasping-sucking type using the elongated lacinia as a basic component. At the end of the line is the order Hemiptera (bugs), in which the mouthparts form a piercing-sucking beak. There are two other groups which appear to result from side branches of the hemipteroid line. In general structure, a peculiar wing venation, reduced tarsi, and many details of bionomics, representative of one line comprising the order Zoraptera (zorapterons), resemble Corrodentia to such an extent that the two seem indubitably closely related. The Zoraptera, however, are more primitive than the Corrodentia in having a large adult pronotum, distinct cerci, and only slightly elongate maxillae. On the basis of this combination of characters it appears that the Zoraptera are the most primitive known members of the hemipteroid line. The other line almost certainly arose from a Corrodentia-like ancestor, became associated with the skin of animals, lived on sloughed skin, material at wounds, and other organic material, and developed into the ectoparasitic order Phthiraptera (chewing and sucking lice). The chisel-like lacinia atrophied in most of these insects. One line of the suborder Mallophaga (chewing lice) apparently began to break

the skin of the host and feed on circulatory fluids. Concurrently with this development the mouthparts became reduced to only the labium and mandibles, and an oesophageal pump developed, used for sucking up this food. The only known representative of this stage is the elephant louse *Haematomyzus* (Ferris 1931, Snodgrass 1944). From a primitive member of this line arose a branch in which a wholly new set of piercing-sucking stylets evolved. This branch developed into the suborder Anoplura (sucking lice). In distinctive characters of digestive tract, tracheal system, male genitalia, and general body segmentation the Anoplura remained remarkably like the Mallophaga.

In the neuropteroid line there occurred a greater suppression of adult characters in the early immature stages, in this line called larvae. First the compound eyes, antennae, and pleural sclerites became greatly reduced in the larvae, the adult structures appearing first in somewhat typical form in the pupal stage. In the adults the mesotrochantin became completely fused with the pleurae except for the pointed tip serving as an articulation for the leg. In many respects the most primitive existing member of this line is the aquatic order Megaloptera (dobsonflies), in which few changes other than those listed seem to have occurred (Kelsey 1954). From a presumably terrestrial pre-megalopteroid ancestor three lines appear to have arisen. In one line the abdomen lost much of its sclerotization. From this line two orders arose, the little-changed Megaloptera and the Neuroptera (lacewings) in which the larval mouthparts became highly modified for sucking and the veins of the wings increased in number.

In the second or raphidian line change was in the direction of consolidation of wing venation and the development of a retractile male genital capsule. The most primitive order of this line, the Raphidiodea (snakeflies), have acquired only early stages of venational change, but in the male genitalia the aedeagus has become securely attached to the claspers. Judging from the extreme similarity of their larvae, the order Coleoptera (beetles) arose from a raphidian-like ancestor in which the

front wings developed into hard wing covers, and the aedeagus, claspers, and part of the ninth segment evolved into a detached, retractile, male genitalic capsule. The origin of the order Hymenoptera is doubtful, but the similarity between the genitalia of the Hymenoptera and Coleoptera and between certain venational features of Hymenoptera and Raphidiodea indicates that the Hymenoptera may have arisen from the same ancestral form as the Coleoptera.

In the third or mecopteran line the first anal vein of the hind wing fused for a short distance at the base with Cu2. The most primitive living representatives of this line belong to the order Mecoptera (scorpionflies). From a pre-mecopterous ancestor arose a branch in which the wing cross-veins became greatly reduced and the longitudinal veins became simplified. The extinct order Paramecoptera probably represents a stage in this process (the fossil order Paratrichoptera belongs to the Mecoptera). From this ancestral form with reduced venation two orders arose, the Trichoptera (caddisflies) in which the larvae became aquatic and lost their spiracles, and the Lepidoptera (moths) in which the larvae remained terrestrial and developed abdominal larvapods armed with circles of hooks.

The evolutionary origin of two orders, the Diptera (flies) and Siphonaptera (fleas), is obscure. Both larvae and adults of living members are so changed from their ancestral forms that obvious tell-tale evidence of relationships is no longer apparent. The Diptera have wings with a simple venation and few cross-veins, and the Siphonaptera have simple, legless larvae much like those of the Diptera. It is possible, therefore, that both orders may have arisen from a common ancestor arising from the Mecoptera-Trichoptera complex. If so, the typical insectan brain of the Siphonaptera larva indicates that this order branched off before the typical Diptera developed (Weber 1954).

Placement of Fossil Orders

Although the approximate phylogenetic placement of many of the fossil insect orders may be surmised with some degree of

accuracy, it is frequently impossible to know exactly where they should be connected on the family tree. This situation results from the fact that characters of body structure and immature stages, necessary for exact phylogenetic placement, are frequently unknown for fossil specimens. An illustration of this concerns the fossil order Protorthoptera, which is apparently a close relative of the orthopteroid orders. It is a curious fact that in all modern members of the orthopteroid orders placed in the accompanying family tree, the first abdominal sternite is greatly reduced or practically absent, indicating that in the stem common to the orthopteroid orders this structure was already lost. The first abdominal segment, however, forms a fairly typical and complete ring, both dorsal and ventral, in the Odonata, Plecoptera, Raphidiodea, and Megaloptera, indicating that in the main line of evolution leading from the earliest winged insects to the genesis of the neuropteroid orders, this first abdominal segment was little modified. If the Protorthoptera should have such an unmodified first abdominal segment it would indicate that it arose earlier on the tree than any existing orthopteroid order. On the other hand, if the Protorthoptera lack the first abdominal sternite, it would indicate a less primitive condition and a point of origin arising closer to the orthopteroid line.

Functional Trends

In retrospect it is obvious that in insect evolution certain developments were dependent on others which preceded them. It is equally certain that the environment must also have contributed conditions complementary to the morphological developments for opportunistic evolution to take place. Insect flight may be an example of just such a union of circumstances.

Wings and flight.—The origin of insect wings is one of the most perplexing problems of insect evolution. No intermediate types are known, living or fossil. Empirically it looks as if first there were wingless insects, then suddenly fully winged ones much as we know them today. But insect wings are such complex structures that it is inconceivable to imagine their origin

other than by slow and gradual change. It seems reasonable to suppose that wings began as flat outgrowths of the thorax used for planing. In attempting to visualize conditions conducive to planing it seems necessary that (1) the insect be of moderate size and weight, so that unaided it would drop rapidly, (2) the body be elongate, tapered, somewhat flattened, and have a posterior tail of some kind, (3) the insect normally run rapidly and climb up on moderately high objects, and (4) the environ-

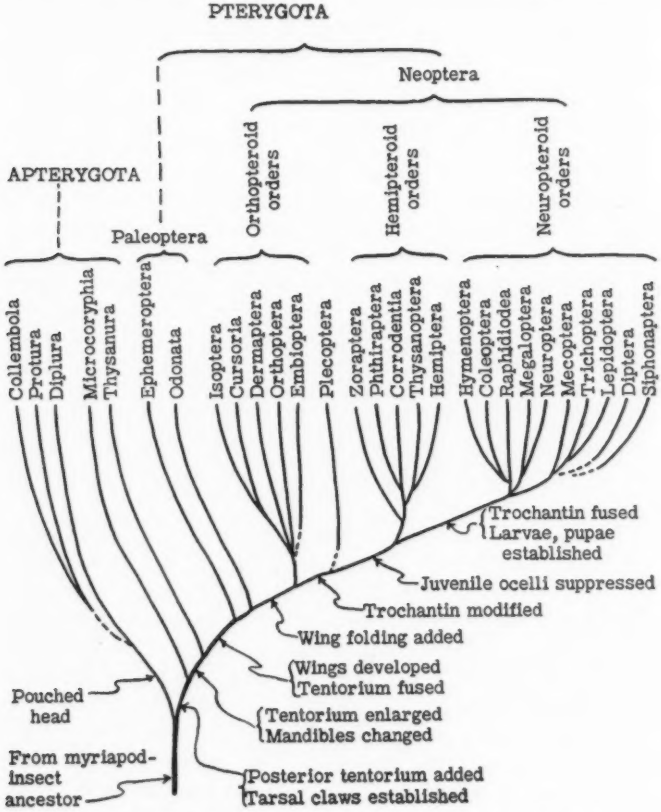

Chart of deduced phylogenetic relationships of the insect orders.

ment provide a maximum of gentle but steady upward air movements.

Undoubtedly the stage for flight in insects was first set by the development of the thorax as the motive center, for this led to a strengthening of the muscles and integument of this region and to a streamlining of the body as a whole. Possibly of equal importance was the development in the primitive insects of paired lateral tarsal claws, for with the reduction of number of legs to three pairs there was a loss by the individual of total gripping power which was regained through the greater efficiency of the paired tarsal claws in comparison with the simple, single, end claw of the ancestral leg. This added traction plus stronger and longer legs would have enabled some large Thysanura-like form to become climbers on tree trunks, in which situation they may have become flattened in form associated with hiding under bark. This combination of circumstances could have set the stage for the habit of jumping from a height, planing, and eventually the evolution of wings and flight. Mills (1955) has suggested that perhaps these forms were not swamp dwellers but lived in hilly or mountainous areas in which upward air currents would be more frequent and prolonged. This might account also for the lack of fossils of such postulated intermediate types. Some authors believe that wings first evolved as paddles for immature aquatic insects. It is difficult for me to be convinced of this when other more efficient systems of propulsion by aquatic nymphs have evolved in the most primitive winged insects.

Molting.—A thought-provoking situation exists concerning molting. In primitive arthropods in general and in nearly all of the Apterygota, molting continues regularly after adulthood. In all the winged insects except the Ephemeroptera molting ceases when functional wings appear, which is in the adult stage, although additional molts may be induced experimentally by hormone manipulation. In the Ephemeroptera, which are the most primitive known winged insects, one molt occurs after functional wings are developed. One wonders if the first winged insects molted continuously throughout life as did their

ancestors but, after wings evolved, selection pressures initiated a trend towards curtailment of post-adult molts. If so, the Ephemeroptera might represent a stage in which this process was almost but not quite completed.

Metamorphosis.—The evolution of the insects beyond the orthopteroid orders is linked with an increased suppression of adult characters in the juveniles. In these cases the tissues which will develop later into the adult characters are maintained in the juvenile stages in an arrested condition as tissue rudiments (histoblasts or anlages). Even in the Apterygota the sexual organs develop in this fashion. In the early Pterygota the wings develop thus although they appear externally as pads increasing with each molt. By the time the hemipteroid ancestor had evolved ocelli were suppressed in the juveniles, and in the neuropteroid insects the compound eyes, antennae, mouthparts, and other structures were added to the list. This trend reaches its peak in the higher Diptera in which the entire head and many other parts are developed from histoblasts. The development of internal wing histoblasts, often considered diagnostic of the neuropteroid orders (the Holometabola), also occurs in the Thysanoptera and some families of Hemiptera, so that the physiological potential for this development must have existed in the pre-hemipteroid ancestor.

This potential seems to rest in the insects' peculiar system of growth-regulating hormones secreted by the corpora alata, prothoracic glands, and other structures. Insect growth is controlled by the balance maintained between the different hormones, and the differential effect of each on histoblastic and functional juvenile tissues. The effect of this arrangement (Williams 1952) has been to allow the larvae and adults to evolve in entirely different directions, the pupal stage acting as an ontogenetic bridge to span the morphological gap between them. Viewed in the light of evolutionary continuity, the pupa is the equivalent of the last nymphal instar of more primitive orders. There seems to be no need to postulate the concept of the pupa as an added instar as has been done by some authors (Snodgrass 1954).

I want to emphasize that the above conclusions are provisional, being an attempt to formulate a scheme of evolution into which all the known facts will fit as harmoniously as possible. Certain apparent conflicting evidence has been explained as either parallel evolution or atrophy. For instance, the Diplura have lateral tarsal claws but the Collembola and Protura have an extremely reduced tracheal system and, at least the Collembola (Paclt 1954), no corpora alata. Since these structures are well developed in other apterygotes and in the myriapod groups, the inference is that they are partially or entirely atrophied in the Collembola and Protura. In the case of these orders distinctive characters of head capsule, mouthparts, and certain leg structures appear to offer a better key to the correct relationships of the orders.

There are many interesting problems awaiting the investigator concerning the relationships between many orders, and it is my hope that this brief summary will encourage students to delve more deeply into these questions. In getting together these ideas, I have profited greatly from discussion with my colleagues at the Survey, particularly Dr. H. B. Mills, Dr. M. W. Sanderson, Dr. L. J. Stannard, and Mr. T. E. Moore, to all of whom I wish to express my thanks.

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Mecinus pyraster (Herbst), A European Genus and Species not heretofore recorded in the United States (Curculionidae, Gymnaetrinae)

By Rose Ella Warner [1]

Mecinus pyraster (Herbst), a species common in Europe, is probably established in the United States but had escaped unnoticed until recently, when it was discovered in the stem of an *Azalea mollis* plant in Cockeysville, Maryland, on Aug. 27, 1954.[2]

Since *Azalea* is not a recorded host plant of this species, further investigations were made and it was found that the weevils had sought shelter in the tunnel of another insect. One hundred plants of a known host, *Plantago lanceolata,* a common plantain abundant in the area where the azalea grew, were examined and three adult weevils were found in galls formed at the base of the plant.

The larvae of *Mecinus* live in *Plantago* and also in several genera of the Scrophulariaceae (*Verbascum, Celsia, Antirrhinum, Linaria, Scrophularia, Veronica,* etc.).

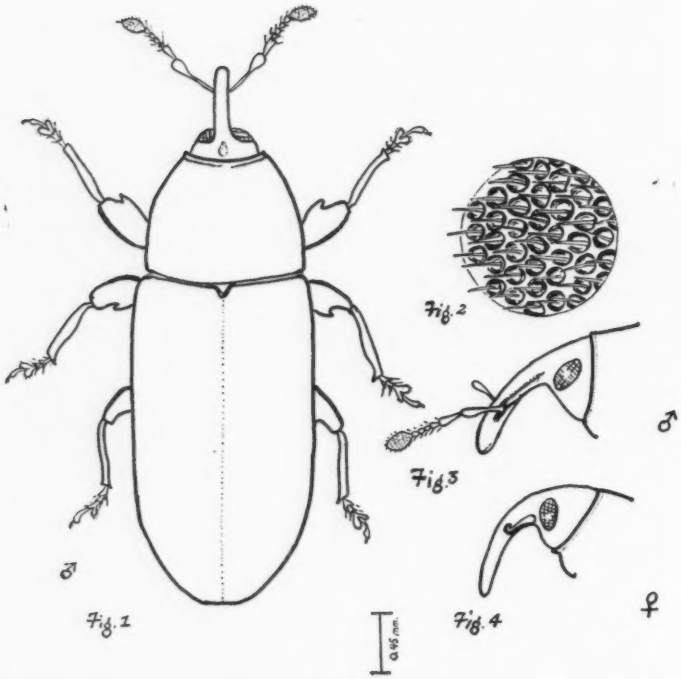
In Europe the beetles mate as early as the middle of May, at which time they are found on the spicate stalks of *Plantago lanceolata.* The eggs, 1 to 3, in number, are found in the pith of the stalk. The first small larvae may be found in June, and in July the larva is 3.5 mm. long and fully grown. The pupae, found in July, are the shape and size (3.5–4 mm.) of the adult beetle which emerges after about six days. Thus the life cycle is completed in slightly over two months.

Description of the adult.—*Mecinus pyraster.*

Black, cylindrical, densely punctate; pubescence light, fine, short recumbent, not hiding the cuticle, dense and white on humeri. Prothorax as wide as the elytra; elytra 2–2½ times as long as wide. Rostrum thick, rugose (♂); smooth, shining,

[1] Entomology Research Branch, Agricultural Research Service, United States Department of Agriculture, Washington 25, D. C.

[2] Wallace Harding, University of Maryland, submitted the original specimens and assisted in the investigations.



Mecinus pyraster (Herbst)

FIG. 1. Outline of male. FIG. 2. Part of prothorax, showing punctures. FIG. 3. Beak of male. FIG. 4. Beak of female.

finely punctate in apical half (♀); regularly arcuate. Antennae in front or near middle (♂); behind middle (♀); 5-segmented, scape short, first segment elongate. Prothorax covered with circular, crowded, but distinct punctures; subparallel in basal half; posterior angles very little rounded. Scutellum triangular, tomentose, white. Elytra with strong striae, their punctures deep, deeper and narrower at apex, intervals flat, uniserially punctate, suture and adjacent interval with brown coarse hairs on apical declivity. Femora stout, dentate or un-

armed. Tibiae slender, spur at apex. Tarsi slender, reddish; claws connate at base, black. Length 3.5–4 mm.

All the species of the genus *Mecinus* Germar 1821 can be separated from those of the genus *Gymnaetron* Schon 1826, by their elongated shape. The species of *Gymnaetron* has a short oval shape except *G. elongatum* Bris. From the species of *Miarus* Steph 1831, *Mecinus* can be separated by its front coxae which are contiguous and by its connate claws. In *Miarus* the front coxae are separate and claws free. The genus *Mecinus* resembles the baridine *Limnobaris* but can be readily distinguished from it by the 5-segmented funicle of the antennae.

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Four New Species of Scleroracus from the United States and Canada (Homoptera, Cicadellidae)

By J. T. MEDLER [1]

Several years ago the writer undertook a revisional study of the genus *Scleroracus* Van Duzee (= *Ophiola* auct.) in North America. Various circumstances have prevented the completion of the manuscript, but there is a need to have available at this time the names of four new species which have distribution in Canada. Therefore, the following descriptions are published in advance of the generic revision.

[1] Associate Professor in Agronomy and Entomology, University of Wisconsin, Madison, Wisconsin.

Scleroracus dasidus n. sp.

Superficially resembles *osborni* (Ball) but distinguished by its smaller size, different leg markings and distinctive internal male genitalia. In distribution in North America, *dasidus* appears to be more western and *osborni* more eastern, but both species are found in the Rocky Mountain region. Length: male 4.0 mm., female 4.3 mm. Width of head across the eyes: male 1.3 mm., female 1.5 mm. Crown obtusely angular, one and one-third longer at middle than against the eye, about half as long as the pronotum.

Color: light tan in general appearance. Crown, pronotum and scutellum with dark brown markings, those on the pronotum of the male more extensive than on the female. Crown with well-defined transverse bands in the pattern characteristic for most species in the genus. Ocelli red. Elytra glossy, subhyaline in appearance, veins white, edged rather narrowly with fuscous. Legs light tan, the femora of the anterior and middle pair banded with fuscous at the base and just before the apex.

Genitalia: female sternite VII tan, the posterior margin slightly produced at the middle and marked with fuscous. Male aedeagus as illustrated in figure 1.

Holotype male and *allotype* female, Logan Canyon, UTAH, July 26, 1915.

Paratypes: 1 ♂, 2 ♀♀, Logan Canyon, Utah, July 26, 1915; 1 ♀, Logan Canyon, Utah, July 24, 1910; 1 ♀, Provo, Utah, July 11, 1908; 1 ♂, 2 ♀♀, Cataldo, Ida., July 9, 1935 (P. W. Oman); 1 ♂, 1 ♀, Kaslo, B. C., July 16 (A. N. Caudell); 1 ♀, Kaslo, B. C., 1903 (R. P. Currie); 5 ♂♂, 2 ♀♀, Buckley, Wash., July 6, 1935 (P. W. Oman); 2 ♂♂, 10 ♀♀, Cliffdale, Wash., July 7, 1935 (R. H. Beamer); 1 ♂, Muddy Pass, Colo., Aug. 19 (R. H. Beamer); 1 ♂, Naches, Wash., July 7, 1935 (R. H. Beamer); 1 ♂, Pingree Park, Colo., Aug. 1924 (Beamer and Lawson); 2 ♀♀, Grand Teton Natl. Park, Aug. 18, 1931; 1 ♀, Siskiyou N. F., Calif., July 14, 1935 (R. H. Beamer); 17 ♀♀, Satus Pass, Wash., July 9, 1935; 1 ♀, Mafeking, Man., Aug. 3,

1937; 2 ♀♀, Merritt, B. C., August 3, 1931; 2 ♀♀, 4 ♂♂, Red Deer River, Man., Aug. 3, 1937; 1 ♀, Birch River, Man., Aug. 3, 1937; 2 ♀♀, Keld, Man., Aug. 8, 1937 (R. H. Beamer); 6 ♀♀, Deepdale, Man., Aug. 1, 1937 (R. H. Beamer).

Types and paratypes in the United States National Museum; paratypes in the Kansas University Museum and Canadian National Museum.

Also examined: specimens from Kolowna, B. C., Aug. 14, 1950 (B. P. Beirne), and Saskatoon, Sask., July 15, 1929 (K. M. King).

Scleroracus kryptus n. sp.

Resembles *S. uhleri* (Ball) in size and external appearance, and difficult to distinguish from that species except by an examination of the internal male genitalia. Length: male 4.3 mm., female 4.6 mm. Width of head across the eyes: male 1.3 mm., female 1.6 mm. Crown obtusely angular, one and one-half longer at middle than against the eye, one-half as long as the pronotum.

Color: black in general appearance, male darker than female. Crown, pronotum, and scutellum of female with black dots, arcs, and bars on a tawny background; male with black much more extensive, the crown with only 3 small tawny spots near the apex and an irregular tawny line at the posterior margin. Ocelli of male red. Elytra with varnished appearance: male entirely dark fuscous except for the faint veins and a clear spot at the apex of the central anteapical cell; female veins distinct, off-white, outlined with dark fuscous markings in the cells; apical cells entirely fuscous, a fuscous band separating the whitish areas in the discal and anteapical cells. Venter and legs black, the anterior and middle pair of legs tawny-yellow from just below the apex of femora. Hind tibia with spines yellow.

Genitalia: female sternite VII with posterior margin obtusely angled at the lateral angles. Male aedeagus as illustrated in figure 2.

Holotype male and *allotype* female, Muskego, WISCONSIN, July 21, 1939 (P. B. Lawson).

Paratypes: 1 ♂, 14 ♀♀, Keld, Man., Aug. 8, 1937 (R. H. Beamer); 3 ♀♀, Swan River, Man., Aug. 2, 1937 (R. H. Beamer); 7 ♀♀, Deepdale, Man., Aug. 1, 1937 (R. H. Beamer).

Types and paratypes in Kansas University Museum; paratypes in the United States National Museum and Canadian National Museum.

Also examined: 2 ♂♂, Lac Mondor Ste. Flore, P. Q., Aug. 3, 1951 (E. G. Munroe).

Scleroracus melastigmus n. sp.

This species resembles *varus* (Ball) in form, but is smaller, has much different coloration and the internal male genitalia are distinct. Length: male 4.0 mm., female 4.2 mm. Head width across the eyes: male 1.4 mm., female 1.5 mm. Crown roundingly obtuse, slightly longer at middle than against the eyes, about half as long as the pronotum. Female elytra only slightly longer than abdomen, giving a somewhat stubby appearance.

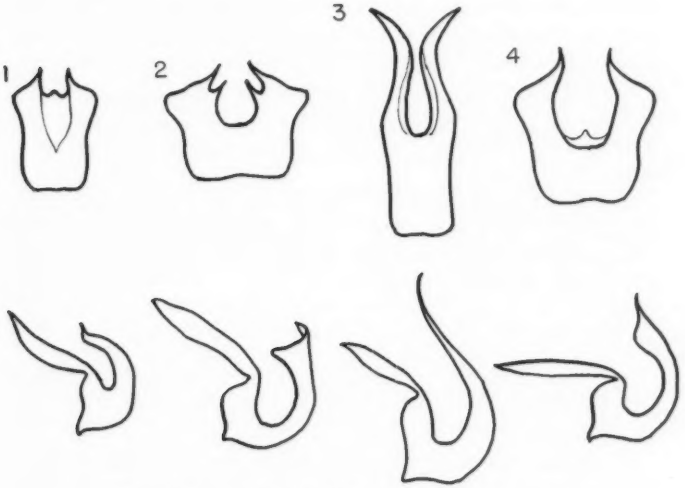
Color: male brown; female brown with shadings of orange. Crown with heavy transverse band between the eyes posterior to ocelli; black on male; brown-orange on female. Small brown arcs near apex, tawny along the posterior margin. Ocelli red. Pronotum heavily mottled with brown. Elytra with veins white, cells heavily infuscated, cells at the apex have the central portion subhyaline. Venter of female tawny, tinged with red; male darker. Legs light brown, the anterior and middle femora of male with a broad dark-brown band at base and a narrow band near apex.

Genitalia: female sternite VII tawny, broadly marked with brown and somewhat produced on the posterior margin. Male aedeagus as illustrated in figure 3.

Holotype male and *allotype* female, Red Deer R., MANITOBA, Aug. 3, 1937 (R. H. Beamer).

Paratypes: 3 ♂♂, 1 ♀, Keld, Man., Aug. 8, 1937 (R. H. Beamer); 4 ♂♂, 1 ♀, Deepdale, Man., Aug. 1, 1937 (R. H. Beamer); 4 ♂♂, Swan River, Man., Aug. 2, 1937 (R. H. Beamer); 1 ♂, Bozeman, Mont., Aug. 13, 1931 (R. H. Beamer), 1 ♀, Cameron's Pass, Colo., Aug. 20, 1940 (R. H. Beamer).

Types and paratypes in the Kansas University Museum, paratypes in the United States National Museum and the Canadian National Museum.



FIGS. 1 to 4. Caudal and lateral views of aedeagus

1. *Scleroracus dasidus* n. sp.
2. *S. kryptus* n. sp.
3. *S. melastigmus* n. sp.
4. *S. omani* n. sp.

Scleroracus omani n. sp.

Resembles *symphoricarpae* (Ball) but with broader head, darker markings and distinct internal male genitalia. Length: male 4.3 mm., female 5.2 mm. Width of head across the eyes:

male 1.5 mm., female 1.7 mm. Crown obtusely angled and slightly longer at middle than against the eye, slightly more than half as long as the pronotum.

Color: female testaceous-orange in general appearance, the male more strongly fuscous. Crown with transverse narrow brown band posterior to ocelli, small brown arcs near the apex, remainder of markings orange. Ocelli red. Pronotum and scutellum with brown markings on male, orange on female. Elytra orange-brown, veins white, edged with brown. Distinct white spot at the apex of each claval vein, on the nervure between claval suture and adjacent claval vein, and on the first cross nervure. The cells are infuscated to a varying amount, but posterior part of the inner and central anteapical cells with distinct clear areas. Venter and legs tawny, the fore and middle femora entirely dark brown except just before the apex, quite distinct on the male, but may be somewhat faded out on the female.

Genitalia: female sternite VII tawny, slightly produced at the middle. Male aedeagus as illustrated in figure 4.

Holotype male and *allotype* female, Park Rapids, MINNESOTA, July 24, 1935 (Oman).

Paratypes: 11 ♂♂, 7 ♀♀, Park Rapids, Minn., July 24, 1935 (Oman); 1 ♂, Black Foot Hills, Alta., Aug. 9, 1940 (A. R. Brooks); 1 ♀, Fish Creek, Wis., Aug. 14, 1926 (P. B. Lawson); 2 ♀♀, St. Paul, Minn., July 21, 1935 and Aug. 7, 1936, U. Farm, Light trap (A. A. Granovsky).

Types and paratypes in the United States National Museum; paratypes in the Kansas University Museum, Canadian National Museum and the University of Minnesota Museum.

This species was misidentified as *symphoricarpae* in part by Medler, 1942, Minn. Tech. Bul. 155, p. 86.

I take great pleasure in dedicating this handsome species to Dr. P. W. Oman, eminent student of the leafhoppers.

New Records for North-American Cerambycidae and a New Subspecies of Leptura

(Notes on North-American Coleoptera, No. 1)

By Charles S. Papp, Pan-Pacific Entomological Laboratory, Pasadena, California

1481 **Chion cinctus** (Drury). As new locality Hope, Ark., 3 specimens in my collection, collected on August 22, 1946. In some collections it is misidentified as the genus *Eburia*.

14190 **Eburia quadrigeminata** (Say). An eastern species. I have 5 specimens from Galena, Illinois, June 19, 1878, and 6 specimens from Hope, Ark., July 7, 1923.

14465 **Strangalepta pubera** (Say). Known from Canada and the western states. Two specimens in my collection, collected by A. B. Klots, Putnam, Conn., June 27, 1932.

14469 **Strangalepta vittata** (Oliv.). Of this northeastern species I have 22 specimens mostly collected by me in Rochester, N. Y. and Fishers, N. Y. and Charlton, Ontario, Canada. One additional specimen from Brownsville, Texas and one from Inboden, Ark. indicate the most southern point of its distribution.

14474 **Strangalia propinqua** (Bland.). In the three western states, mostly on Cruciferae. I have 3 specimens from Truchas, Mt. Sangre de Cristo Range, 9,000 ft. elev. in New Mexico, August 5, 1932; 6 specimens from Little Tuseque Canyon, vic. Santa Fe, N. Mex., 9,200 ft. elev., July 27–August 10, 1932; 1 specimen from La Veta Pass, vic. La Veta in Colorado, 9,300 ft. elev., July 22, 1932. New for New Mexico and Colorado.

14522 **Leptura nigrolineata** Bland. Well known from Colorado as a typical species from this location. I have 28 specimens belonging to this species that appear to represent a new subspecies.

Leptura nigrolineata truxali n. subsp.

Differs because of its narrow dark antennae and narrow lateral margins of the elytra; the punctuation of the light-

brown elytra is extremely fine, the shining black prothorax with extremely long yellow hairs.

Holotype male, Truchas Mt., Sangre de Cristo Range, alt. 9,000 ft. NEW MEXICO, Aug. 5, 1932 and *allotype* female, Little Tesuque Canyon, vic. Santa Fe, alt. 9,200 ft., July 27–August 10, 1932. *Paratypes:* 4 males, from Little Tesuque Canyon, and 4 females from Little Tesuque Canyon and from the Truchas, transferred from my collection to that of the Los Angeles County Museum, Dept. of Entomology. Dedicated to my friend and colleague Dr. F. Truxal in the Los Angeles Co. Museum.

14605 **Rosalia funebris** Mots. Recently I have received 17 specimens from Wellington, B. C., including 3 specimens (2 male and 1 female) with very heavy black markings, completely black shoulders and epipleura, and with all the separated light-blue markings relatively very small.

14620 **Callidium antennatum** Newm. Has a wide distribution, more common in the Atlantic States, Indiana, Florida, sporadically listed from southern Calif. and Oregon. A dozen specimens in my collection from Summerlands, B. C., March 10, 1932, transferred from the A. J. Mutchler collection. This is the most northern distribution of the species collected in quantities.

14898 **Monochamnus maculosus** Hald. It is well known throughout the states of Arizona, Colorado, and New Mexico but is not a common species. I have an exceptionally large male specimen from Tucson, Arizona (28 mm) and a smaller one (also a male) from Whitehall, Eldorado County in California, collected on June 21, 1931. A few specimens were collected by F. Truxal and L. Martin in the Madera Canyon, Santa Rita Mts., in southern Arizona and are now in the collection of the Los Angeles County Museum.

14901 **Monochamnus notatus** Drury. Recorded from Jeannette, Pa., June 1930, as additional data on distribution from the eastern United States. The large male has antennae 65 mm. in length.

14902 **Monochamnus obtusus** Casey. This species occurs from Washington, Idaho, and throughout California. I have one specimen from the Mutchler collection (det. by Mutchler) with New York City on the locality label.

14928 **Synaphaeta guexi** (Lec.). This species was formerly known only from the west coast, particularly from the vicinity of Vancouver, B. C. and sporadically through southern California. On August 2, 1954 I received a shipment of beetles, collected by Dr. John Adams Comstock (Del Mar, Calif.) from Madera Canyon in the Santa Rita Mountains, southern Arizona. In this shipment was one specimen of this species, collected on July 30, 1954, at light. This is the first specimen recorded from Arizona. Three other specimens in my collection are from California, 2 from Anaheim and 1 from Berkeley.

14960 **Astylopsis maculata** (Say). Eleven specimens of this northwestern species were taken in June 1954 by me and my son in Mint Canyon, Los Angeles County in California. All of them are typical specimens, 2 of which have been placed in the Coleoptera collection of the Los Angeles County Museum. This is the southernmost point recorded for this grayish-white beetle. Length: 5–8 mm.

14976 **Leiopus fascicularis** (Harris). Occurs in Indiana. I have one specimen from Rochester, N. Y., July 8, 1932, and 2 specimens from Albany, N. Y., August 22, 1941.

14985 **Leiopus alpha** (Say). Two new localities: Missouri (Wentzville, June 10, 1949), 8 specimens, and Oklahoma (Vinita, no date), 13 specimens. Have 2 specimens from Tucson, Arizona, collected on August 4, 1947, which two specimens are lighter in color, otherwise like the typical form.

14968 **Leiopus variegatus** (Hald.). As an additional note on its distribution I would like to mention my two specimens from Kentucky. No further information on the labels (marked: Ky.).

15021 **Urographis fasciata** (DeG.). I know of only one specimen recorded from south of Lake Ontario, from Rochester,

N. Y., June 29, 1933, collected by M. G. Jeffers. The specimen is in my collection.

15028 **Graphisorus obliquus** Lec. I have one male from Little Tesuque Canyon in the vicinity of Santa Fe, New Mexico, collected at 9,200 ft., between July 27–August 10, 1932. This specimen has been transferred from the A. J. Mutchler collection into the author's private collection. (I have one specimen of *G. obsoletus* Oliv. also from the Mutchler collection, without locality label.)

15061 **Pogonocherus oregonus** Lec. Well known from Oregon, California and Idaho. One specimen collected by Lloyd Martin in the Madera Canyon, Santa Rita Mts. in Pima County, southern Arizona. The grey pubescence darker than in the specimens from California. One other typical specimen in my collection is from Pohoho Trail, Calif., alt. 7,000–7,750 ft., June 12, 1931.

15084 **Oncideres putator** Thoms. In Dillon's paper, the distribution is given as Mexico and Guatemala. I have 2 small specimens, one male and one female from the Merrill-collection, both collected at State College, New Mexico, in August (no year on the label). The species is usually 21.5–24.5 mm. in length; my male specimen is 14 mm. Differs from the typical form by its more fulvous pubescence. In other characters entirely different from the *ssp. brevifasciata* Dillon & Dillon (p. 360).

15088 **Oncideres cingulata** Say. A widely distributed species, ranging from Connecticut south and west to Texas and into Mexico. I have one specimen from the A. J. Mutchler collection, collected by T. M. Little in Newman's Lake, Alachua County, Florida, December 15, 1931. This specimen has a wide dark-colored band on the shoulder and two small blackish spots behind the eyes. Its pubescence is perfectly preserved.

15134 **Oberea schaumi** Lec. Two specimens collected by F. C. Fletcher in Rochester, N. Y. on June 23, 1943 and July 1, 1943, are in my collection. *Not* from California!

A New Species of Aneflus from Arizona (Coleoptera: Cerambycidae)

By Josef N. Knull, Department of Zoology and Entomology, The Ohio State University

In identifying some Cerambycidae the following apparently undescribed species was found.

Aneflus parcalvatus n. sp.

Male. Size and form of *A. calvatus* Horn, elongate, subcylindrical, dark brown, clothed with short recumbent pubescence, small irregular patches of pubescence on elytra.

Head coarsely punctured; antennae when laid along side, extending to apical sixth of elytra, ratio of lengths of segments 1 to 11, 3:.5:2.4:2.4:3:2.8:2.8:2.6:2.6:2.6:3.3, scape subcylindrical, under side of apex slightly emarginate, segments three to seven inclusive spinose at apex, segments five to eleven flattened, carinate, eleventh feebly appendiculate.

Pronotum wider than long, widest at middle, wider at base than at apex; sides rounded with an obtuse tubercle at middle on each side; disk convex with five irregular rugose areas, one in center back of middle, and two on each side, a transverse depression at base; surface rugose. Scutellum densely clothed with recumbent pubescence.

Elytra at base much wider than widest part of pronotum; sides subparallel, broadly rounded in apical sixth to strongly bispinose apices; disk convex with two rather weak costae on each elytron; surface coarsely punctured at base, punctures becoming smaller toward apices.

Abdomen beneath finely punctured, pubescence not dense; last visible sternite broadly emarginate.

Length 35 mm.; width 8.3 mm.

Female. Differs from male by antennae extending to about middle of elytra. Last visible sternite broadly rounded.

Holotype male and *allotype* collected in Santa Rita Mountains, Arizona, July 11, 1949 by D. J. and J. N. Knull. *Paratypes* from Arizona as follows: Tucson, July, 1911 and 1919,

G. Hofer; Sabino Canyon, July 12, 1920, G. Hofer and W. D. Edmonston; Nogales, July 7, 1949, D. J. and J. N. Knull, in collection of author; and Tucson, July 5, 1954, M. A. Cazier and W. J. Gertsch, in American Museum of Natural History.

This species can be separated from *A. calvatus* Horn, which it resembles, by the wider prothorax and the mottled pubescence on elytra.

Tenth International Congress of Entomology

The Tenth International Congress will be held in MONTREAL from 17 to 25 August, 1956. The meetings will be held at McGill University and the University of Montreal.

Fifteen sections have been arranged provisionally as follows: Systematics, Morphology and Anatomy, Physiology, Behavior, Ecology, Geographical Distribution, Genetics and Biometrics, Paleontology, Arachnida and other land Arthropods, Agricultural Entomology, Forest Entomology, Medical and Veterinary Entomology, Stored Products Entomology, Biological Control, Apiculture.

Those wishing to receive further information with a view of attending the Congress should notify the Secretary as soon as possible. Those wishing to receive a personal invitation are requested to apply to the Secretary. J. A. DOWNES, Secretary, Division of Entomology, Science Service Building, Ottawa, Ontario, Canada.

Professor Bradley Honored

Professor Emeritus **J. Chester Bradley** of Cornell University has been elected an HONORARY FELLOW of the ROYAL ENTOMOLOGICAL SOCIETY OF LONDON. Only rarely has this honor been bestowed outside Great Britain, and, at present, Dr. R. E. SNODGRASS is the only other American Honorary Fellow.

Professor Bradley retired from active teaching at Cornell in 1952. He has been a Resident Member of the American Entomological Society since 1902, and he was one of the founders of the original Entomological Society of America in 1906.

Obituary

The President of Harvard University has informed the NEWS of the death of **Charles Thomas Brues,** Professor of Entomology, *Emeritus,* and Honorary Curator of Parasitic Hymenoptera, which occurred on the twenty-second of July, in the seventy-seventh year of his age. Funeral services were held in Crescent City, Florida, on Sunday, July 24.

Professor Brues was a Corresponding Member of the American Entomological Society.

Review

THE EVOLUTION AND TAXONOMY OF THE SARCOPHAGINAE (DIPTERA, SARCOPHAGIDAE). By Selwyn S. Roback. Illinois Biological Monographs: Vol. 23, Nos. 3–4. Pp. 181. The University of Illinois Press, Urbana, 1954.

This seems to be a major addition to the study of the Sarcophagidae. It is a concise account of the subfamily Sarcophaginae, a group of some economic importance. The actual text is relatively short since 77 of the 181 numbered pages consist of charts and plates and their explanations. This publication is essentially an introduction to the study of the Sarcophaginae with a wealth of basic information condensed in a small space.

There are six chapters of which the ones on morphology and terminology and classification are most important. There are keys to tribes, subtribes and genera and each genus is characterized and the general distribution indicated. An important part of the generic discussion is a list of included species. It is not likely that other workers will be in complete agreement here but at least there is no question of Roback's personal concept of each genus.

The plates consist entirely of figures of genitalia. The bibliography appears to be quite complete and the index is useful.

This is a basic work and we hope other subfamilies will be treated in a like manner.—L. L. PECHUMAN.

EXCHANGES

This column is intended only for wants and exchanges, not for advertisements of goods for sale or services rendered. Notices not exceeding three lines free to subscribers.

These notices are continued as long as our limited space will allow; the new ones are added at the end of the column, and, only when necessary those at the top (being longest in) are discontinued.

Cynipid and Itonidid galls—American species wanted; purchase or exchange for British species. Fresh or dried. D. Leatherdale, F.R.E.S., Old Woodstock, Oxford, England.

Wanted—Reprints or papers concerning insects taken in Alaska for inclusion in list of Alaskan insects. R. H. Washburn, Alaska Experiment Station, Palmer, Alaska.

Conopidae of the World wanted. Will pay 10¢ to $1.00 for pinned and labelled specimens. S. Camras, 4407 N. Milwaukee Ave., Chicago 30, Illinois.

Anisoptera—Nearctic sp. wanted for exchange, espec. Ophiog., Arigom., Aeschna, Neurocor., Somatoc., Cordulia, Dorocor., Leucor. R. D. Cuyler, Dept. of Entomology, N. C. State College, Raleigh, N. C.

Bembicini and Stizini (Hym., Sphec.) of New World wanted for revis. study. Will return upon request or at end of project. James E. Gillaspy, Dept. of Zoology, Univ. Texas, Austin 12, Texas.

Agapema galbina. Will exchange cocoons of this moth for nature books. E. Frizzell, Route 4, Box 96, San Benito, Texas.

Wanted—Data on exact location of colonies of *Epibembex* (olim *Bembix*) (Hymenoptera), any species, any part of country, for biological studies. Howard E. Evans, Dept. Entomology, Cornell Univ., Ithaca, N. Y.

Fanniinae wanted on loan (nearctic and holarctic), and information on collections. James G. Chillcott, Dept. Entom., Univ. of Kansas, Lawrence, Kan. (Loans may be charged to Dr. C. D. Michener.)

Tenebrionidae of the World wanted, in exchange for insects of Argentina and neighboring countries. Horacio J. Molinari, Av. Lib. Gral. San Martin 55, Acassuso (Buenos Aires), Rep. Argentina.

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